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## A GEOLOGICAL SECTION ACROSS SOUTHERN INDIANA, FROM HANOVER TO VINCENNES.

### INTRODUCTION.

DURING the field season of 1896 the Indiana University Geological Survey undertook to map, geologically and topographically, a section across southern Indiana, reaching from the Ohio River at Hanover on the east, to the Wabash River at Vincennes on the west. The strip of country mapped is 6 miles wide, 120 miles long, and is embraced in the row of townships numbered 3 north.

### METHOD OF RUNNING THE SECTION.

The topographic work was done by means of aneroid barometers, with a line of levels through the territory by which the aneroid readings were checked. This line was run as far as Willow Valley station in Martin county, and as near the middle of the strip of country to be mapped as the conditions would permit; the elevations were obtained by means of the vertical arc, and are as accurate as the necessities of ordinary topography and geological cross sections demand. The line of levels was checked on the J. M. & I. and the B. & O. S.-W. R. R., where these roads were crossed. The dips of strata as shown by these levels may be depended upon within the suggested limits.

The section chosen was selected because the geological horizons and the topography crossed by it are typical of almost the entire southern part of the state. The geological horizons cannot be taken up here in detail, but it is desired to point out some of the relations existing between the topography and the geology.

### THE HORIZONS CROSSED AND THE RESULTING TOPOGRAPHY.

*The eastern plateau.*—Beginning in the east near Hanover, at the west side of township 3 north 10 east, the lowest rocks



exposed in Indiana are the limestones and calcareous shales of the Cincinnati group. Near Hanover these beds have an exposed thickness of about 250 feet, reaching from near the tops of the bluffs along the Ohio River down to and below the level of that stream, which at this place is about 400 feet above mean tide. Overlying this series of soft strata are hard limestones belonging to the Clinton, Niagara, and Devonian (Corniferous). The combined thickness of these beds is about 180 feet.

The limestones resist the action of the weather, and owing to these hard, resisting strata above, and the soft, easily eroded strata below, the conditions are favorable to the formation of bluffs and waterfalls. So it happens that each short stream that flows eastward into the Ohio has the upper end of its gorge marked by a precipice or waterfall, varying in height from 40 to 90 feet.

When the top of the limestone is reached the country immediately becomes approximately level. The Devonian limestone is overlain by the Devonian black shale, and as this shale has no hard beds immediately overlying it, it does not produce a rugged topography. The dip of the Devonian limestone from Big Spring, township 3 north 9 east, section 16 to section 20, 3 north 8 east is 231 feet, or a little over 33 feet to the mile. This dip is not constant, but varies from 20 to 46 feet per mile, and is in every respect sufficient to cause the westward flow of the streams.

In the eastern edge of Scott county the westward dip of the Devonian limestone and the overlying Devonian black shale is probably at its minimum; the hills of this locality, and the exposures of limestone in the valleys, are probably due to this structural feature. While the hills are not high—ranging from 50 to 100 feet above the valleys—they nevertheless form the most marked topographic feature between the Ohio River and the Knobs.

The Devonian limestone finally passes beneath the drainage near the west line of township 8 east, the country immediately

to the west becomes more gently rolling, and the low hills are made up of black shale covered over in most cases by glacial material.

The Devonian black shale outcrops over a strip of country some twelve miles wide. Except at its eastern edge where it has been eroded to a feather edge, and where the underlying limestone controls the topography, it forms very low hills, and often almost flat plains. The black shale passes beneath the drainage near Scottsburg. In a deep well drilled at Scottsburg its thickness was found to be 120 feet.

*The eastern lowland.*—Overlying the Devonian black shale is the Knobstone group of clay shales, sandy shales, and sandstones. The lower limit of this group is marked by the Rockford Goniatite limestone, which, owing to its thinness has but little effect on the topography. The lowest beds of the Knobstone group are made up of clay shales. These clay shales, with the underlying Devonian black shale, are directly responsible for the low country and very gentle topography to be found throughout southern Indiana, between the high escarpment known as the Knobs, and the deep gorge of the Ohio River. The western part of this region may be properly styled the eastern lowland.

One noticeable feature of the topography from the top of the escarpment near Hanover, where the elevation is 800 feet above tide, to Scottsburg (570 feet above tide), is the gradual westward slope of the country, corresponding almost exactly to the average dip of the strata. The tops of the low hills of this region are all found in approximately the same slightly westward dipping plain.

*The "Knobs" and the middle plateau.*—The Knobs form by far the most important topographic feature in the eastern part of the extreme southern portion of Indiana. They are made up of Carboniferous strata belonging to the "Knobstone group" with its capping Carboniferous limestones. The Knobs do not form a range of hills, properly speaking, but are rather a high escarpment, generally facing eastward, with a plateau sloping

very gently to the west, and with outliers to the east. The geological conditions, so far as they bear upon topography, are very similar to those along the Ohio River, to the east, *i. e.*, a thick series of soft and unresisting strata is capped by sandstone and more resisting limestones, thus making possible bold hills and steep slopes.

The parting between the Knobstone and the overlying limestone is not a sharp one, but is made up of interstratified limy and sandy layers, indicating a gradual change in the conditions of sedimentation. The easternmost point in the line of parting between the Knobstone group and the overlying limestone is at the southeast corner of section 18, 3 north 5 east. Passing on westward the top of the Knobstone is found lower and lower in the hills, until it finally passes beneath the drainage in the northeast quarter of section 19, 3 north 3 east, at an elevation of 537 feet, or 342 feet lower than its outcrop, just eleven and one-half miles east. This shows a general westward dip averaging about twenty-six feet per mile.

*The sink hole region.*—Overlying the Knobstone group, and still dipping to the west are the Harrodsburg and Mitchell limestones (of Hopkins and Siebenthal), and the Kaskaskia group, all belonging to the Lower Carboniferous. In the region of its easternmost exposure the limestone is very thin, being eroded to a feather edge. Passing westward from its easternmost exposure, it is found lower and lower in the hills, because of its westward dip, and the country becomes accordingly less rugged and takes on the gently rolling and pitted sink hole character common in limestone regions.

In this region and on westward across the outcropping Mitchell limestones, and until the Kaskaskia beds are reached, the country has a very gentle westward slope. This is less, however, than is to be found east of the "Knobs," and it is also less than the dip of the rocks; this is due to the fact that the limestones do not weather so easily as do the shales.

There is a noticeable increase in the size of the sink holes in going across the limestone region from east to west. The sink

holes at the eastern edge are rarely more than 20 feet deep and 200 yards across, while in the western part they are sometimes miles in length and from 50 to 200 feet deep, forming valleys, similar in every respect to ordinary valleys of erosion, except that they have no surface outlets for their drainage. The increase in the size of the sink holes is, of course, due to the greater thickness of the underlying limestone.

The western edge of the Mitchell limestone is found just west of the second principal meridian, where, overlying it, is the lower Kaskaskia limestone, a hard, close-grained, resisting bed, which is in turn overlain by a series of limestones and sandstones. The effect of these beds upon the topography is quite noticeable. The hills rise higher and higher to the west, until on the western edge of Lawrence county, where they are capped by the highest beds of the Kaskaskia group, they are from 100 to 250 feet above the valleys. Many of these valleys are only large sink holes, and have no surface outlets.

*The Mansfield sandstone, or western plateau.*—Overlying the Kaskaskia beds is the Millstone grit (Mansfield sandstone of Hopkins) or the sandstone that forms the lowest member of the Upper Carboniferous. This sandstone controls the topography in the region in which it forms the surface rock, and is, in the main, responsible for the high hills of Martin county. It has a gentle westward dip and owing to this fact the highest hills of the region are found near its eastern limit. The hills decrease in height with the dip of the rocks to the west. The resulting topography is essentially that of a thoroughly dissected plateau.

*The western lowland.*—The Mansfield sandstone is finally lost to view at the western edge of Martin county, a short distance east of Loogootee. West of this point the country is level, or very gently rolling. There is here an abrupt transition from the rugged hills capped with sandstone, in Martin county to the much lower, level country underlain by coal-bearing shales and sandstones at the east side of Washington county.

Overlying the Mansfield sandstone, and extending from its upper limit to the west line of the state, the country is underlain

by the coal-bearing shales and sandstones of the Upper Carboniferous. These beds are easily attacked by eroding agencies, and have, therefore, already been worn down very near to their base level of erosion (if, indeed, they have ever been high above that level), leaving a comparatively level flat country. This region is covered with more or less glacial material.

The accompanying profile section shows clearly these different topographic features, and also the relations between the topography and the underlying strata.

#### CONCLUSION.

In conclusion, attention should be called to the following points :

*a.* In passing from east to west across southern Indiana, three prominent topographic features are crossed, and these features are the results of combinations of strata as follows: (1) the high eastward escarpment along the Ohio River caused by a thick series of easily eroded calcareous shales overlain by thick and resisting limestones; (2) the high eastward-facing escarpment with its outliers to the east, known as the "Knobs." This escarpment is the result of a thick series of soft clay and sandy shales, protected by sandstones and resisting limestones. Along the line under discussion this escarpment is twenty-eight miles west of the escarpment along the Ohio; (3) the high hills of Martin county, which are the result of a series of limestones and sandstones capped by more resisting sandstones and which do not rise as an escarpment from the east, but become gradually higher, owing to the resisting nature of their lowest beds. The distance from the Knobstone escarpment to the highest hills capped with the Mansfield sandstone is about thirty miles.

*b.* The structure of each of these topographic features where crossed by the section is essentially the same in different stages of development, *i. e.*, that of a dissected plateau, sloping gently to the west. In the eastern, or the Devonian limestone plateau, in the region of Ohio, dissection has scarcely begun, as none except the streams flowing directly into the Ohio have deep



gorges, and these are only from one-half to one and a half miles long ; in the middle, or Knobstone plateau, dissection has progressed much further than in the eastern one ; while the western or Mansfield sandstone plateau has been completely dissected by its streams.

It is possible that this peculiarity in the amount of erosion that has taken place in these different plateaus is the result of the character and former upward extension of the overlying formations in each case.

c. The top of the eastern plateau where crossed by the section is 800 feet above the sea, that of the middle is 820 feet, and that of the western 880 feet above tide, while but a short distance to the north or south the topographic sheets show the elevations of these plateaus to correspond even more closely.

These closely corresponding elevations point strongly to the conclusion that the present topography of southern Indiana has developed from an old base level ; a former plain of deposition, or a combination of the two, might, however, have given rise to the present conditions.

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